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(54) Abstract Title: **Active projection system**

(57) An Apparatus for the illumination of surroundings includes an infra red camera (22) generating data representing a two dimensional thermal image scene relating to the surroundings; a data processing system (26) for processing the data representing a two dimensional thermal image scene relating to the surroundings to produce an illumination intensity pattern therefrom; and a projector (36) for projecting the illumination intensity pattern onto the surroundings. The apparatus enables the visibility of objects to be enhanced.

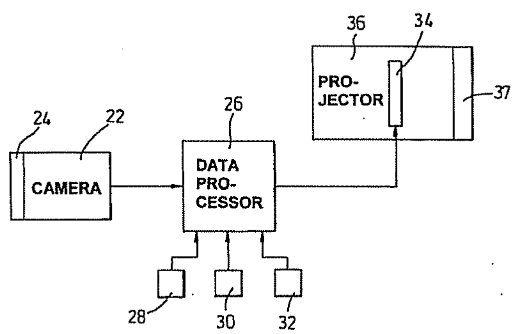

Fig. 3

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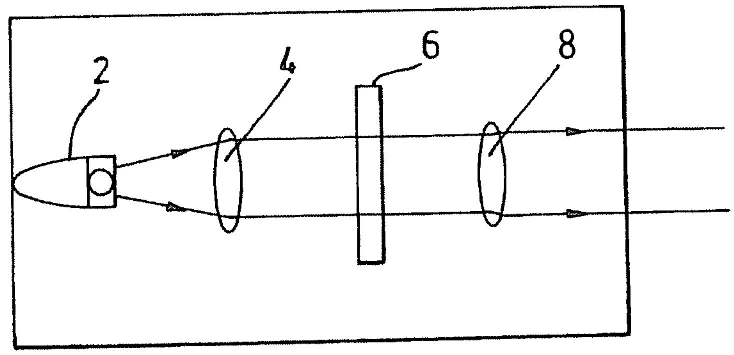


Fig. 1

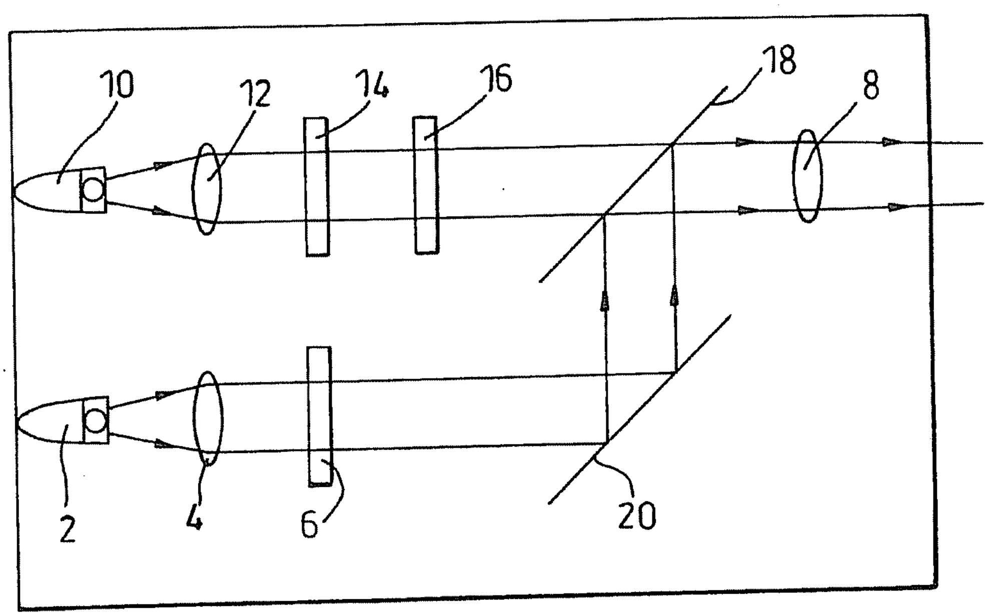
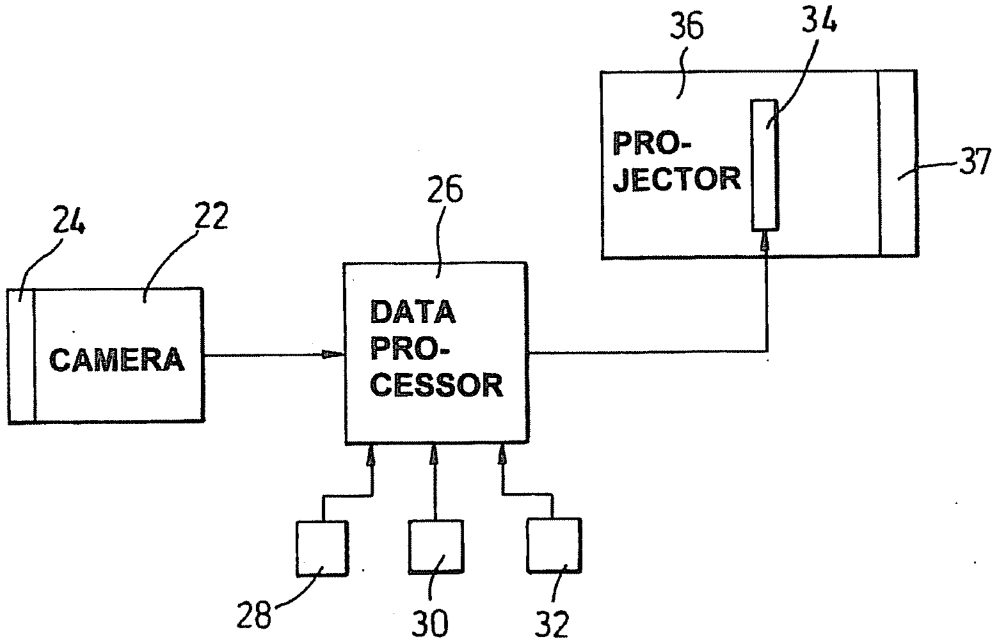
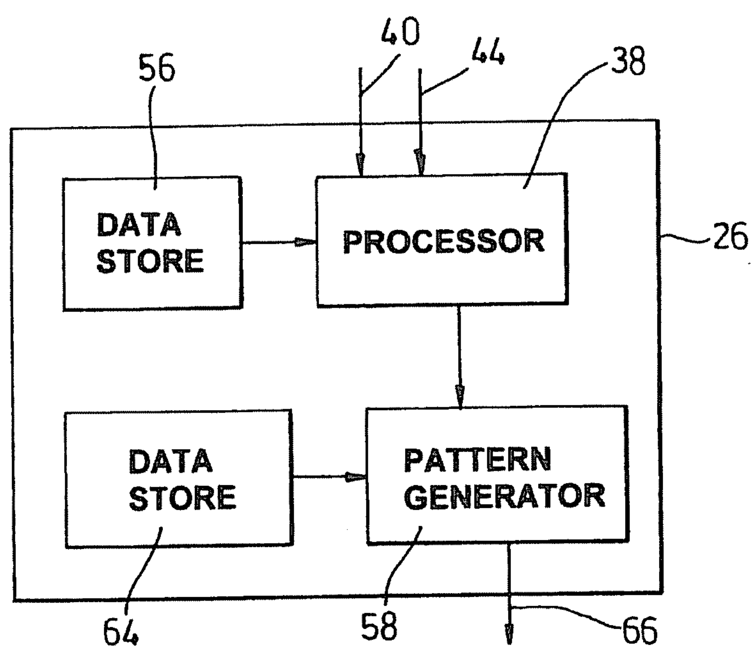


Fig. 2



36
34
PRO-
JECTOR
37
26
24
22
DATA
PRO-
CESSOR
CAMERA
28
30
32

Fig. 3



40
44
56
38
DATA
STORE
PROCESSOR
26
DATA
STORE
PATTERN
GENERATOR
64
58
66

Fig. 4

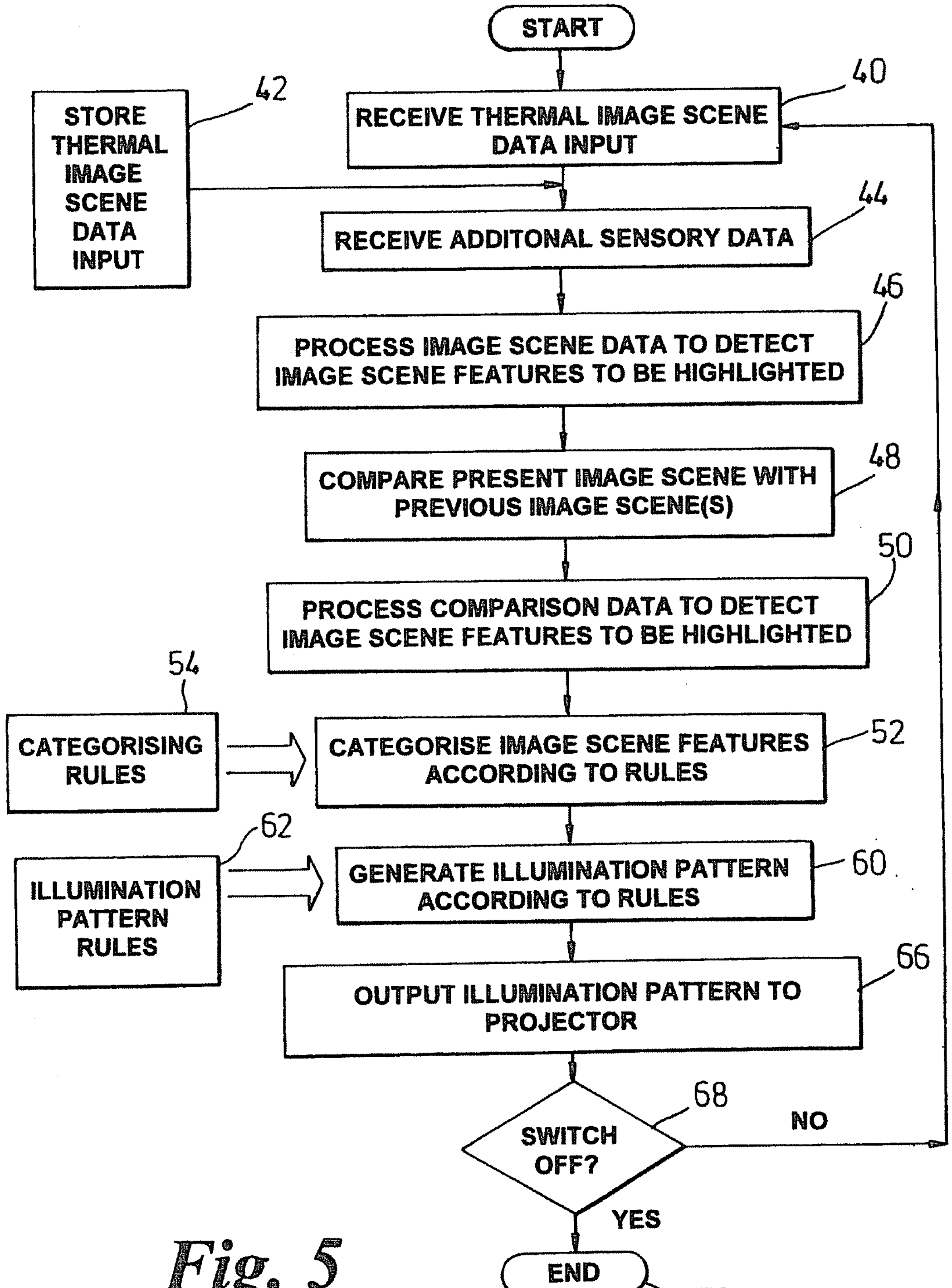

START
RECEIVE THERMAL IMAGE SCENE DATA INPUT
40
STORE THERMAL IMAGE SCENE DATA INPUT
42
RECEIVE ADDITONAL SENSORY DATA
44
PROCESS IMAGE SCENE DATA TO DETECT IMAGE SCENE FEATURES TO BE HIGHLIGHTED
46
COMPARE PRESENT IMAGE SCENE WITH PREVIOUS IMAGE SCENE(S)
48
PROCESS COMPARISON DATA TO DETECT IMAGE SCENE FEATURES TO BE HIGHLIGHTED
50
CATEGORISING RULES
54
CATEGORISE IMAGE SCENE FEATURES ACCORDING TO RULES
52
ILLUMINATION PATTERN RULES
62
GENERATE ILLUMINATION PATTERN ACCORDING TO RULES
60
OUTPUT ILLUMINATION PATTERN TO PROJECTOR
66
SWITCH OFF?
68
NO
YES
END
70

Fig. 5

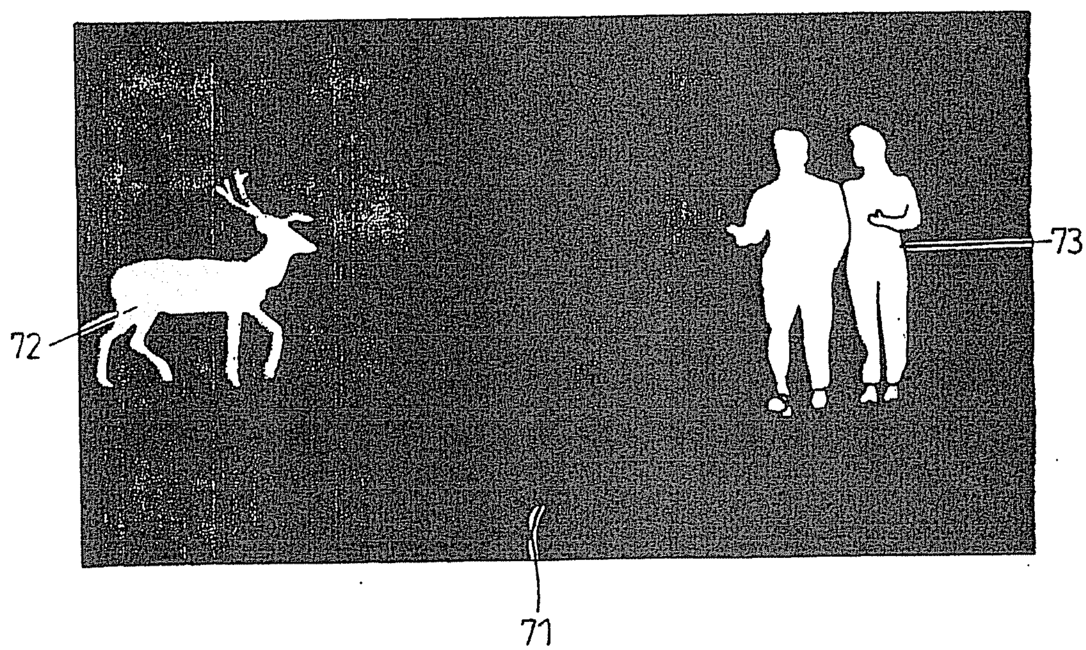


Fig. 6a

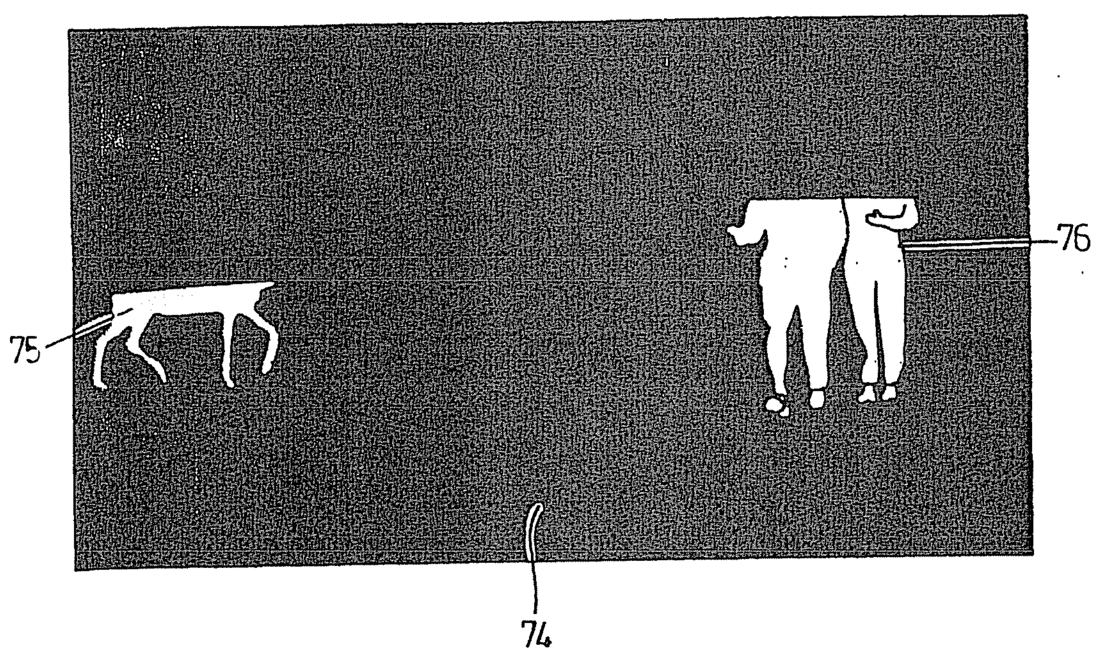


Fig. 6b

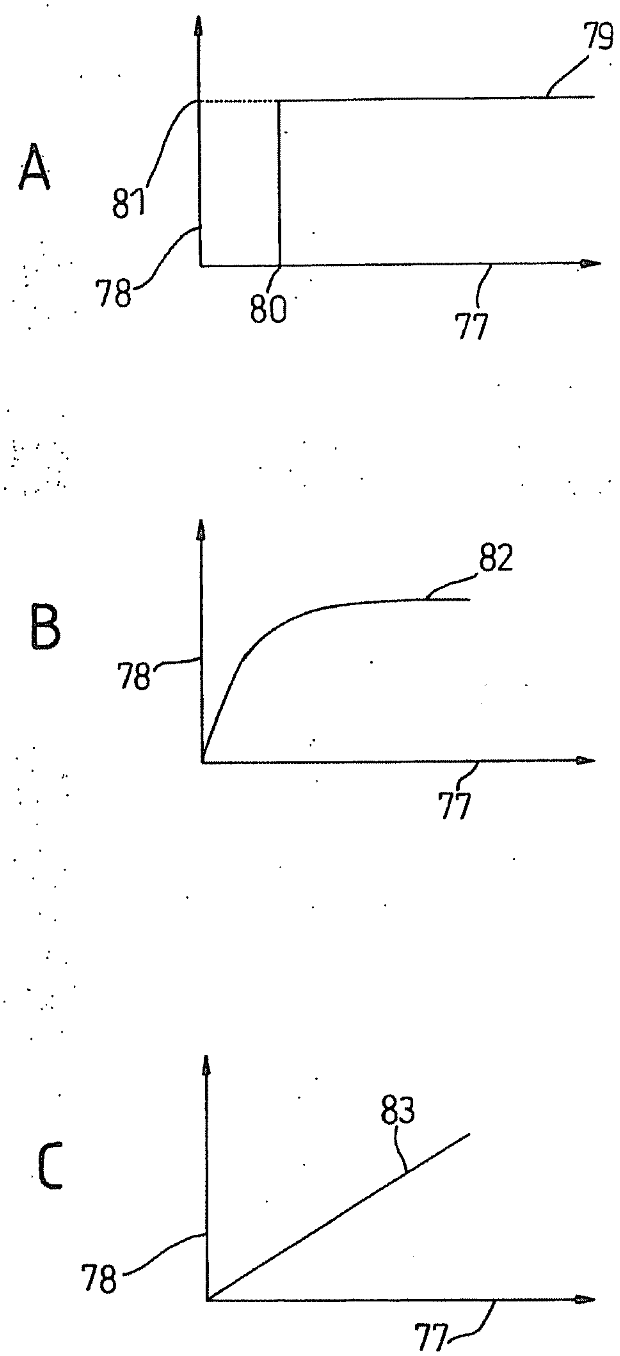


Fig. 7

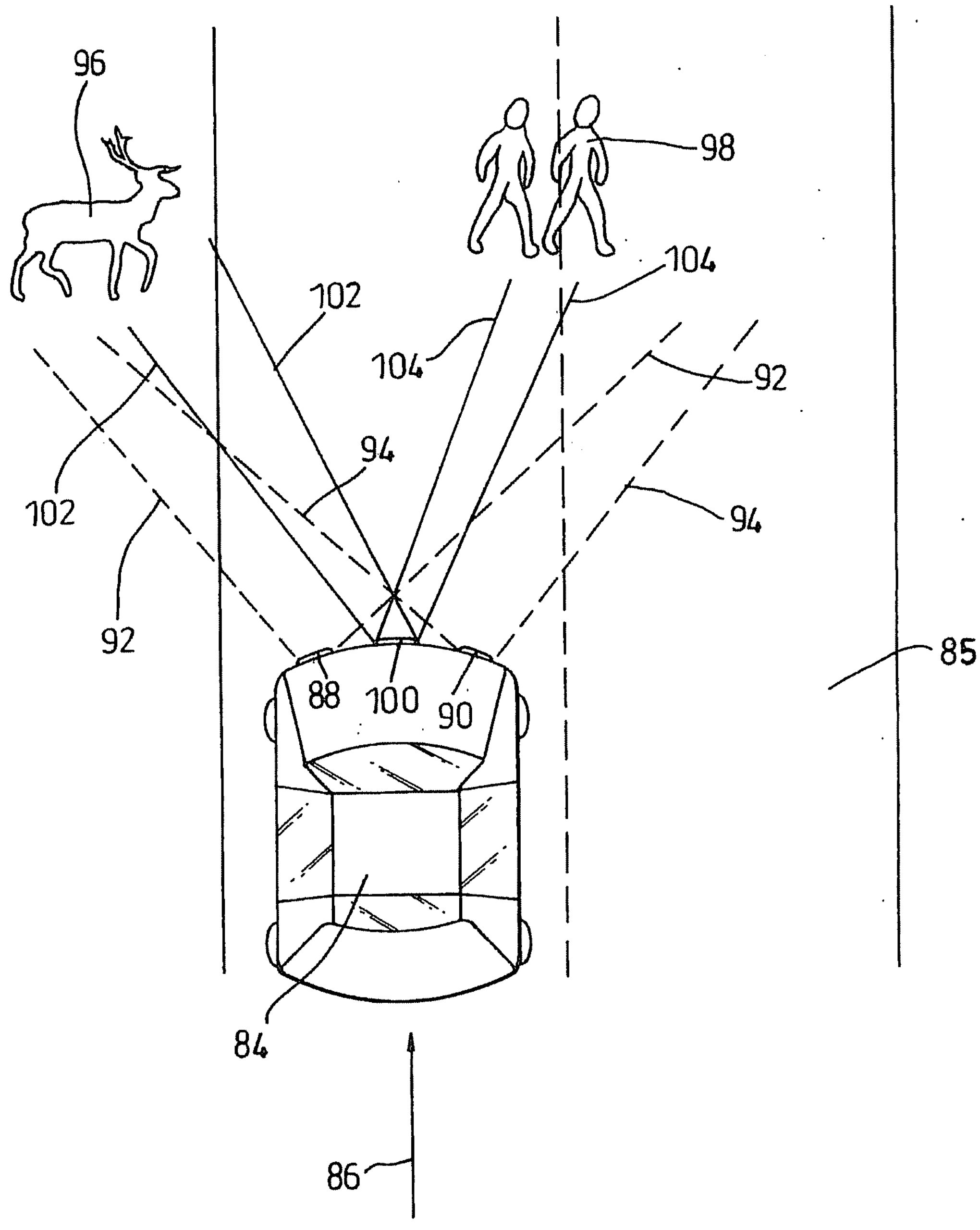


Fig. 8

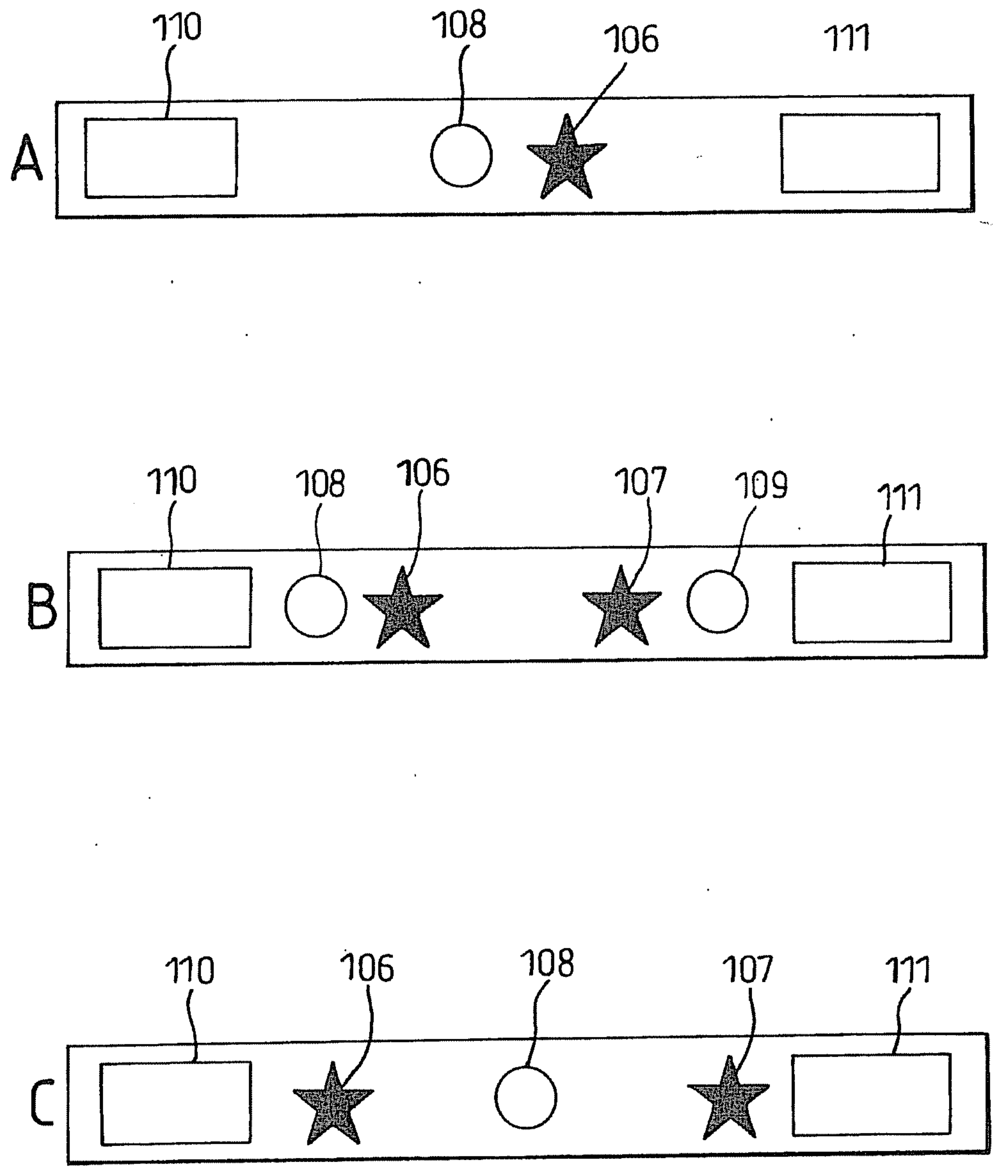


Fig. 9

Interactive Lighting System

Field of the Present Invention

The present invention relates to the interactive lighting of surroundings, in particular, but not exclusively to the oncoming surroundings of a vehicle such as a car.

Background

The driver of a vehicle, for example a car, needs to be aware when driving, sufficiently in advance, of any features of the oncoming surroundings posing as a potential hazard or danger. This allows the driver to drive more safely. This is more difficult in low light conditions and at night. In these poor lighting conditions it generally takes longer for the driver to become aware of potential hazards than in good lighting conditions despite the use of standard illumination means of the oncoming surroundings.

Standard illumination means for the oncoming surroundings of a car generally involves the projection onto the surroundings of two overlapping beams of illumination of a single level of intensity. Such a method for illumination, although providing a general illumination of the oncoming surroundings and therefore any potential hazards and dangers also, cannot alert the driver to any oncoming hazardous features in particular over less hazardous features of the oncoming surroundings. Additionally, the driver cannot be informed of the nature of features of the oncoming surroundings by the characteristics of the illumination.

Patent application US 6,144,158 describes an adaptive headlight device which modifies the intensity and angular aim of one or more micro-beams of a headlight beam upon detection of incoming light radiation. The purpose is to prevent the dazzling of oncoming drivers of vehicles by dimming the region of illumination corresponding to the oncoming vehicle.

Patent application US 6,403,942 describes a headlamp control system wherein the intensity of an illumination of the oncoming vehicle surroundings is varied according to a detection of further vehicles in the surroundings.

It is noted that an intelligent lighting system is described in the paper "Pixel Light", Martin Enders, BMW Group, Germany, PAL 2001 Symposium, Darmstadt University of Technology describes a Digital Micro Mirror Device (DMD) used in an interactive lighting system which is capable of amplifying the contrast of objects such as traffic signs, pedestrians, bicyclists, pavement markings and obstacles. However, the manner in which features are distinguished and how an illumination pattern is generated is not clear, and does not address the issue of reducing complexity in the data processing system.

In accordance with the present invention, there is provided apparatus for the illumination of surroundings including:

a) an infra red camera generating data representing a two dimensional thermal image scene relating to the surroundings;

b) a data processing system for processing the data representing a two dimensional thermal image scene relating to the surroundings to produce an illumination intensity pattern therefrom; and

c) a projector for projecting the illumination intensity pattern onto the surroundings, wherein the data processing system is arranged to process the data representing a two dimensional thermal image scene relating to the surroundings in accordance with predetermined rules for categorising features of the two dimensional thermal image scene and wherein the categorising rules include rules relating to features which are moving within the two dimensional thermal image scene.

The present invention provides apparatus for the interactive illumination of the oncoming surroundings capable of varying characteristics of the illumination projected onto the oncoming surroundings. By basing the illumination pattern on thermal image data, a large majority of sensed features which are moving, such as animated objects, including humans and animals, and vehicles, and which are therefore generally of greatest potential hazard, can be highlighted directly using a relatively small amount of processing power and/or with increased speed of interaction.

Different features of the oncoming surroundings can be differently illuminated such that the driver is sooner alerted to oncoming potential hazards and dangers as well as useful features of the surroundings such as a road sign. The characteristics of the illumination for a feature of the oncoming surroundings also provide the driver with information about the nature of the oncoming feature.

Preferably, the data processing system applies a function, for example a thresholding function, to a thermal image scene of the vehicle surroundings to produce the illumination intensity pattern.

Further features and advantages of the invention will become apparent from the following description of preferred embodiments of the invention, given by way of example only, made with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a schematic diagram of a projector for use in an interactive lighting system, in accordance with an embodiment of the present invention;

Figure 2 is a schematic diagram of an alternative projector for use in accordance with an embodiment of the present invention;

Figure 3 shows schematically a diagram of an embodiment of the present invention;

Figure 4 shows schematically a data processing system for use in an interactive lighting system, in accordance with an embodiment of the present invention;

Figure 5 is a flow diagram showing a process followed by a data processing system in accordance with an embodiment of the present invention;

Figure 6a shows an image scene of surroundings in accordance with an embodiment of the present invention;

Figure 6b shows an illumination intensity pattern for surroundings in accordance with an embodiment of the present invention;

Figure 7 shows representative plots of different functions applied to an image scene in accordance with an embodiment of the present invention;

Figure 8 is a schematic diagram of an application of an interactive lighting system in accordance with an embodiment of the present invention; and

Figure 9 shows different mounting configurations of lighting systems in accordance with embodiments of the present invention.

Figure 1 shows a projector for use in an embodiment of the present invention. In this example the projector is mounted on a vehicle by appropriate means, for example a car. A description of the structure and function of the projector follows. The projector in this embodiment is capable of projecting an illumination pattern of only a single resultant colour of light. A light source 2, for example a Xenon gas discharge lamp emits a beam of light which is collimated by a collimator lens 4. The collimated beam next passes through an illumination intensity modulator. In this embodiment, the illumination intensity modulator comprises a matrix of at least sixty four liquid crystal cells 6. The arrangement of liquid crystals in one liquid crystal cell of the matrix can be controllably varied by varying an applied voltage across a set of electrodes of the liquid crystal cell. Through a combination of differently applied voltages across individual liquid crystal cells of the matrix, an overall configuration of the matrix of liquid crystal cells can be achieved. Such an overall configuration corresponds to a desired pattern of illumination intensities. Thus, the collimated light beam when passing through the matrix of liquid crystal cells 6 is modulated such that a light beam with a specific illumination intensity pattern results. The light beam with the specific illumination intensity pattern is subsequently focused by an objective lens 8 onto the surroundings of the car. Figure 2 shows schematically an alternative projector for the projection of an illumination intensity pattern. In this embodiment of the present invention, the projector is again mounted on a vehicle, in this example a car, by appropriate means. In this embodiment, however, the projector is capable of producing an illumination comprising various colours unlike that described in the first embodiment.

Elements of the projector described in this embodiment are similar to those of the projector of Figure 1. These elements are referenced in Figure 2 with the same numerical labels therein and the relevant descriptions according to structure and function should be taken to apply herein also. The projector comprises a first and a second light source 2, 10, the second light source 10 being similar to the first light source 2 as described in the previous embodiment. The light beam from the second light source has a different optical path to that from the first light source 2. The light beam from the second light source is collimated by a collimator lens 12 and is then modulated by a second matrix of liquid crystal cells 14, similar to that as described for the previous embodiment. The overall configuration of the second matrix of liquid crystal cells 14 preferably complements the overall configuration of the first matrix of liquid crystal cells 6. The light beam with an illumination intensity pattern modulated by the second matrix of liquid crystal cells 14 passes through a light filter 16 from which emerges light of a specific desired frequency. The desired frequency is selected depending on the desired colours of the illumination intensity pattern to be projected. The light beam passes from the light filter 16 through a dichroic mirror 18. At this point, the light beam from the first light source 2 joins the optical path of the light beam from the second light source 10. In order for this to be achieved, the optical path of the light beam from the first light source is reflected by a folding mirror 20 and the dichroic folding mirror 18. The now combined light beams with preferably complementary illumination intensity patterns are focused by the objective lens 8 onto the vehicle surroundings. The surroundings are therefore illuminated by an illumination intensity pattern of at least one colour comprising the individual illumination intensity patterns of the light beams from the first and second light sources.

Figure 3 schematically shows an interactive lighting system of a vehicle, for example a car, according to an embodiment of the present invention. An infra red camera 22 generates data which represents a two dimensional thermal image scene of the vehicle surroundings. The generated data of the two dimensional thermal image scene includes information on the

intensity of thermal radiation, in the form of infra red radiation, emitted by features of the vehicle surroundings. It should be noted that the thermal radiation detected by the infra red camera is solely emitted by the features of the vehicle surroundings and is therefore of a passive nature. The infra red camera 22 is fitted with a visible light filter 24 in a manner which prevents the interference of visible light with the thermal image scene being detected by the infra red camera.

The generated data representing the two dimensional thermal image scene is sent to a data processing system 26. The data processing system also receives additional data relating to the surroundings of the vehicle from a plurality of dedicated sensors 28, 30, 32. The additional data relates to parameters of the vehicle and its surroundings including: the temperature, the humidity, the light conditions, the speed of the vehicle, the angle of steering of the vehicle, the list of the vehicle. It is also envisaged that a radar device can be used to provide further data relating to the vehicle surroundings. Following receipt of the thermal image scene data and the additional data, the data processing system 26 generates an illumination intensity pattern using this received data.

A description of further details of the structure and functioning of the data processing system 26 follows shortly using Figures 4 and 5. Data representing the generated illumination intensity pattern is sent from the data processing system 26 to a matrix of liquid crystal cells 34 of a projector 36, similar to that described for a projector of an embodiment of the present invention, as shown using Figures 1 or 2. The data representing the generated illumination intensity pattern results in a specific overall configuration of applied voltages across electrodes of the individual liquid crystal cells such that the projector 36 projects an illumination intensity pattern onto the vehicle surroundings that is tailored to the features of the vehicle surroundings. An infra red filter 37 is fitted to the projector in a manner to prevent any emission of infra red radiation onto the vehicle surroundings. Such an emission of infra red radiation would interfere with thermal image scene data detected by the infra red camera 22.

It should be noted that in further envisaged embodiments of the present invention, wherein the projector includes a plurality of liquid crystal cell matrices, the data representing the generated illumination intensity pattern is sent to each individual matrix of liquid crystal cells. Alternatively, it is envisaged that the data representing the generated illumination intensity pattern is broken down by the data processing system 26 into data signals specific to each matrix of liquid crystal cells of the projector.

Referring now to both Figures 4 and 5, Figure 4 shows a schematic diagram of the data processing system 26 in accordance with an embodiment of the present invention. Figure 5 shows a flow diagram of the processes followed by the data processing system 26. An image scene processing unit 38 receives, as already described, data 40 representing the two dimensional thermal image scene from the infra red camera. The image processing unit 38 stores this thermal image scene data 42 and the additional data relating to the vehicle surroundings is received 44.

According to the level of thermal intensity of features of the two dimensional thermal image scene and specific properties of the additional data, features of the vehicle surroundings are highlighted 46 by the image scene processing unit 38. One example of the use of the additional data is the temperature of the vehicle surroundings. The thermal intensity of features of the vehicle surroundings detected by the infra red camera relative to the thermal intensity of the background is affected by the temperature of the vehicle surroundings. This factor is included in the processing of the data by the image processing unit 38. In this embodiment, data representing a second thermal image scene of the vehicle surroundings is detected by the infra red camera and sent to the image processing unit 38 at a predetermined time period after the sending of the data representing the initial thermal image scene. This second thermal image scene is compared 48 against the initial thermal image scene as already stored 42.

Based on this comparison, further features of the image scene are highlighted 50 by the image processing unit 38. The comparison involves detection of a change in position across the image scene or a change in size,

thus indicating the speed and direction of motion, of features of the image scene of the vehicle surroundings. It is also envisaged that a comparison may be performed between two subsequent values of the additional data to further highlight features of the vehicle surroundings.

Once the features of the thermal image scene vehicle surroundings have been highlighted, they are categorised 52 according to a predetermined set of categorising rules 54 which are stored in a first rule data store 56.

The categorising rules analyse the highlighted features of the image scene and categorise them according to a plurality of characteristics. Possible characteristics include: the speed of motion of the feature, the direction of motion of the feature, the thermal intensity of the feature, the size of the feature, the shape of the feature. Depending on specific details of these characteristics the features are categorised into one of a plurality of categories. One such example of these categories is according to a hazard priority rating. For example, if a feature has the correct thermal intensity, size and shape of a human, this feature will be designated a 'hazard 1' category indicating that this feature has a high hazard priority. A further feature having characteristics corresponding to a cat, for example, could be given a 'hazard 2' category, indicating that this feature has a lower hazard priority than the human given the 'hazard 1' category. Alternative envisaged categories into which the features are sorted are according to the type of feature. These, for example, could include: humans, animals, trees, cars, road signs, buildings and miscellaneous, non-hazardous objects. Once the features of the image scene have been categorised, data detailing the categorisation of the features is sent from the image processing unit 38 to an illumination intensity pattern generating unit 58. Here an illumination intensity pattern is generated 60 by applying a set of illumination intensity pattern rules 62 which are stored in a second rule data store 64. The designated category of the features of the image scene determines characteristics of the illumination intensity pattern to be generated, as stated by the illumination intensity pattern rules 62. Characteristics of the illumination intensity pattern to be generated influenced by the illumination pattern rules include: the intensity of a region of the

illumination intensity pattern, the colour of a region of the illumination intensity pattern, the shaping of a region of the illumination intensity patterns to form a symbol or an arrow for example, applying a flashing pattern of illumination to a region of the illumination intensity pattern, removal of a portion of illumination of a region of the illumination intensity pattern to prevent dazzling of a feature of the image scene.

Figure 6a shows an exemplary two dimensional thermal image scene 71 detected by the infra red camera. An animal 72 and two pedestrians 73 are easily identifiable in the image scene against the background due to their high thermal intensity.

Figure 6b shows the generated illumination intensity pattern 74 for the thermal image scene 71 as shown in Figure 6a. Following the application of the illumination pattern rules, regions of the illumination intensity pattern 74 corresponding to the animal 75 and the two pedestrians 76 of the image scene are modified so as not to illuminate a top portion of the features thus preventing dazzling.

In generation of the illumination intensity pattern, the illumination intensity of regions of the illumination intensity pattern, according to features of the image scene, are determined by applying a function, for example a thresholding function, to the level of thermal intensity of the specific feature.

For example, selection of features with specific thermal characteristics may be made, thus discriminating between animals or humans and very hot objects such as vehicle exhaust systems.

Figure 7 shows graphical plots A, B, C showing different functions applied by the illumination intensity pattern generating unit to the data representing the two dimensional thermal image scene. All plots show a first axis 77 corresponding to the level of thermal intensity of a feature of the vehicle surroundings and a second axis 78 perpendicular to the first axis 77 corresponding to the level of illumination intensity of the appropriate region of the illumination intensity pattern. Plot A shows the effect of a thresholding function 79 on the intensity of a region of the illumination intensity pattern. When the thermal intensity of a feature is below a threshold value 80 the

region of the illumination intensity pattern has an illumination intensity of zero. When the thermal intensity of a feature is equal to or above the threshold value 80, the corresponding region of the illumination intensity pattern now has a predetermined level of illumination intensity 81.

Plot B shows an envisaged alternative function applied to the thermal intensity data of a feature of the thermal image scene. This alternative function is non-linear 82 such that the difference in illumination intensity between two regions of the illumination intensity pattern is not directly proportional to the corresponding difference in level of thermal intensity of two features of the image scene.

Plot C shows a further envisaged alternative function applied to the thermal intensity data of a feature of the thermal image scene. This alternative function is linear 83 such that the difference in illumination intensity between two regions of the illumination intensity pattern is directly proportional to the corresponding difference in level of thermal intensity of the two features.

Another example of the application of illumination pattern rules involves a region of the generated illumination intensity pattern corresponding to a 'hazard 1' priority feature of the thermal image scene could be illuminated in red and with a high illumination intensity so that all features of the image scene with a 'hazard 1' priority stand out more boldly than other features to the driver of the vehicle. A further example involves a feature of the image scene moving at a high speed towards the infra red camera of the interactive lighting system and deemed by the data processing system 26 to impact with the vehicle. In this example, such a feature could be illuminated with a high intensity, rapidly flashing, red coloured illumination region of the illumination intensity pattern such that the driver is urgently alerted to the approaching hazard.

Illumination pattern rules are further envisaged in an alternative embodiment of the present invention to be applied to features of the image scene categorised by the type of the feature, as described previously.

Now referring back to Figures 4 and 5, once the illumination intensity pattern has been generated 60, data representing the illumination intensity pattern is sent 66 to the projector for projecting the illumination intensity pattern onto the vehicle surroundings. If after the projection of the illumination intensity pattern a switch off command 68 is received, then the processing by the data processing system 26 ends 70. If a switch off command is not received, the sequence of steps of processing by the data processing system 26 as shown in Figure 5 is repeated. Generally in all circumstances when the repeated processing cycle occurs, the thermal image scene of the vehicle surroundings detected by the infra red camera is different to that of the previous processing cycle. Consequently, the generated illumination intensity pattern for this different image scene is different to that generated previously. Thus, the illumination intensity pattern projected onto the vehicle surroundings dynamically interacts with the features of the changing vehicle surroundings. This therefore allows features of the vehicle surroundings to be tracked by a region of the illumination intensity pattern as its position relative to the vehicle changes.

Embodiments of the present invention have so far described an interactive lighting system comprising a single infra red camera and a single projector. In these embodiments the infra red camera and the projector are preferably mounted in close proximity to each other at a centre point nearest the front of the vehicle. This close proximity mounting to each other helps to reduce image alignment problems. In further envisaged embodiments of the present invention, the interactive lighting system comprises a further infra red camera and possibly a further projector, both of which are similar to those described previously.

In these embodiments, the infra red cameras are positioned on the vehicle such that a binocular view of the vehicle surroundings is detected through a combination of the individual two dimensional image scene from each infra red camera to produce a three dimensional thermal image scene. This therefore provides distance data of features of the image scene relative to the vehicle, without the need for analysis of size data of the features by the

data processing system 26 as previously described. In the embodiment wherein a further projector is included it is envisaged that the illumination intensity patterns projected are focused such that they complement each other on the vehicle surroundings. Alternatively, one projector projects an illumination intensity pattern onto a portion of the vehicle surroundings and the further projector projects an illumination intensity pattern onto the remaining portion of the vehicle surroundings not covered by that of the first projector.

In accordance with a further embodiment of the present invention, Figure 8 shows an application of the interactive lighting system of a vehicle complementing a non-interactive lighting system of a vehicle, for example a headlight. A vehicle, preferably a car, 84 is driving along a road 85 in a forward direction 86. A non-interactive lighting system includes two headlights 88, 90, each of which projects a fixed illumination delimited by edges 92, 94 respectively onto the vehicle surroundings. This fixed illumination provides a general illumination of the vehicle surroundings to the driver. Each fixed illumination with edges 92, 94 overlaps to an extent with each other and is of a constant level of illumination intensity. As features of the oncoming vehicle surroundings there is an animal 96 standing at the side of the road 85 and two pedestrians 98 standing in the centre of the road 85. Although both of these features of the vehicle surroundings are illuminated generally by the illumination of the non-interactive lighting system, the non-interactive lighting system does not alert the driver of the vehicle to the presence of these features especially. However, with the interactive lighting system complementing the non-interactive lighting system, this alerting of the driver is achieved. As according to the description of the functioning of the data processing system using Figures 4 and 5, analysis of the thermal image scene of the vehicle surroundings by the data processing system results in categorisation of the animal feature 96, and the two pedestrians feature 98 into, for example, the respective categories of 'animal' and 'human'.

As a result, the generated illumination intensity pattern projected by the projector 100 of the interactive lighting system onto the vehicle

surroundings includes a first region delimited by edges 102 of the illumination intensity pattern, for example of a high intensity of white light and modified to avoid dazzling, as described previously using Figures 6a and 6b, aimed specifically at the animal 96. A second region delimited by edges 104 of the illumination intensity pattern, for example of a high intensity of red light and modified to avoid dazzling, is aimed specifically at the pedestrians 98. In this way, the driver is alerted in particular to these features of the vehicle surroundings whilst a general illumination of the oncoming vehicle surroundings is provided.

Figure 9 shows different configurations for the mounting of components of a complementary interactive and non-interactive lighting system one configuration of which was described using Figure 8.

Configuration A of the lighting system corresponds to that shown in Figure 8 and involves the single projector 108 of the interactive lighting system positioned between and on the same horizontal level as the two headlights 110, 111 of the non-interactive lighting system each of which is positioned close to one of the front corners of the vehicle. A single infra red camera 106 is positioned centrally and close to the projector.

Further configurations of the lighting system are envisaged, in particular configuration B wherein an infra red camera 106 and a projector 108 are positioned close to and horizontally level with the front corner positioned first headlight 110 and a second projector 109 and infra red camera 107 are positioned close to the second headlight 111, as viewed from the front of the vehicle, at the other front corner of the vehicle.

A further envisaged configuration C is similar to the embodiment just described with two infra red cameras 106, 107 positioned close to the headlights 110, 111. In this configuration however only one projector 108 exists which is centrally positioned and on the horizontal level with the infra red cameras and headlights. In the case of configurations B and C, the two infra red cameras 106, 107 allow a binocular view of the vehicle surroundings to be obtained to produce a three dimensional thermal image scene as earlier described.

The above embodiments are to be understood as illustrative examples of the invention. Further embodiments are envisaged. For example, an alternative projector for the projecting of the illumination intensity pattern onto the vehicle surroundings is envisaged to comprise three light sources, that produce light beams coloured red, green and blue respectively, which enable an illumination intensity pattern of a greater number of different colours to be projected. Furthermore, instead of using a liquid crystal light valve projector, an alternative may be used, such as a Digital Micro Mirror Device (DMD).

It should be noted that examples given in the description with respect to the application of categorising and illumination pattern rules to features of the image scene are not exhaustive. Further examples include the yellow illumination of a cyclist feature of the image scene, the lower half being illuminated with a brighter intensity to avoid dazzling of the cyclist; the illumination of the position of a pedestrian standing behind a parked car, detected by the high level of thermal intensity of the pedestrian's legs under the parked car; in the case of fog, lane and road markings are illuminated in particular, as also are the positions of hazards within the fog which cannot be easily viewed in the fog by the driver; in the case of an approaching feature of the surroundings which will impact with the vehicle, the position at which point the impact will occur is illuminated.

It should be noted that although all described embodiments of the present invention have related to a lighting system for the illumination of the surroundings of a car, further lighting situations are envisaged as suitable for the present invention. For example, a floodlighting scenario or the use for the surroundings of other types of vehicles other than a car would be suitable for the use of the present invention.

Claims

1. Apparatus for the illumination of surroundings including:

a) an infra red camera generating data representing a two dimensional thermal image scene relating to the surroundings;

b) a data processing system for processing the data representing a two dimensional thermal image scene relating to the surroundings to produce an illumination intensity pattern therefrom; and

c) a projector for projecting the illumination intensity pattern onto the surroundings, wherein the data processing system is arranged to process the data representing a two dimensional thermal image scene relating to the surroundings in accordance with predetermined rules for categorising features of the two dimensional thermal image scene and wherein the categorising rules include rules relating to features which are moving within the two dimensional thermal image scene.

2. Apparatus according to claim 1, wherein the categorising rules relate to features moving across the two dimensional thermal image scene.

3. Apparatus according to claim 1 or claim 2, wherein the categorising rules relate to features of the two dimensional thermal image scene moving towards the infra red camera.

4. Apparatus according to any of claims 1 to 3, wherein the categorising rules further include rules relating to at least one of the shape, size and thermal intensity values of a feature of the two dimensional thermal image scene.

5. Apparatus according to any of claims 1 to 4, wherein said predetermined rules include rules for modifying the generated illumination intensity pattern from the data representing the two dimensional thermal image scene.

6. Apparatus according to claim 5, wherein the modification of the generated illumination intensity pattern follows categorisation of the two dimensional thermal image scene.

7. Apparatus according to any preceding claim, wherein the projector is adapted to project an illumination intensity pattern comprising a plurality of regions of individually controllable illumination intensity.

8. Apparatus according to claim 7, wherein the projector is adapted to project an illumination intensity pattern comprising at least sixty-four regions of individually controllable illumination intensity.

9. Apparatus according to claim 7 or claim 8, wherein the data processing system is arranged to produce a selected illumination intensity of at least one of the individually controllable regions of the illumination intensity pattern from the data representing the two dimensional thermal image scene using a thresholding function.

10. Apparatus according to any preceding claim, wherein said data processing system is arranged to process additional data relating to the surroundings to produce the illumination intensity pattern.

11. Apparatus according to claim 10, wherein the additional data relates to the surroundings including data relating to the motion of the vehicle and/or external conditions of the vehicle.

12. Apparatus according to any preceding claim, wherein at least some of the data relating to the surroundings is updated at a predetermined rate.

13. Apparatus according to claim 12, wherein the illumination intensity pattern is modified at a predetermined rate on the basis of the updated data relating to the surroundings.

14. Apparatus according to any preceding claim, wherein no dedicated source of infra red radiation is associated with the infra red camera.

15. Apparatus according to any preceding claim, wherein the infra red camera includes a visible light filter.

16. Apparatus according to any preceding claim, wherein the illumination intensity pattern projector includes an infra red filter.

17. Apparatus according to any preceding claim, wherein the projector includes an array of liquid crystal elements for modulating light.

18. Apparatus according to any preceding claim, further comprising a non-interactive projector for illuminating the surroundings, such as a headlight.

19. Apparatus according to claim 21, wherein the apparatus associated with the non-interactive projector includes an infra red filter.

20. Apparatus according to any preceding claim, comprising a further infra red camera generating data representing a further two dimensional thermal image scene.

21. Apparatus according to any preceding claim, wherein the data processing system is arranged to process data representing the thermal image scene, from at least two infra red cameras, to generate distance data relating to a feature of the thermal image scene.

22. Apparatus according to claim 21, wherein the data processing system is adapted to process the distance data from a sequence of thermal image scenes to generate movement data relating to a feature of the thermal image scene.

23. Apparatus according to any preceding claim, comprising a further projector for projecting the illumination intensity pattern onto the surroundings.

24. Apparatus according to any preceding claim, wherein said apparatus is adapted to be mounted on a vehicle.

25. A vehicle comprising apparatus according to any preceding claim.

26. Apparatus for the illumination of surroundings substantially as hereinbefore described with reference to the drawings.

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Application No:	GB 0324442.3	**Examiner:**	Jeremy Cowen
Claims searched:	1	**Date of search:**	9 March 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	GB 2334401 A (Zeman), see abstract
A	-	US 4591918 (Hisano) , see abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W]:

H4F

Worldwide search of patent documents classified in the following areas of the IPC[7]:

G06T,H04N

The following online and other databases have been used in the preparation of this search report:

WPI,EPODOC,PAJ